



An Overview of the Human Systems Integration Division

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Human Systems Integration Division

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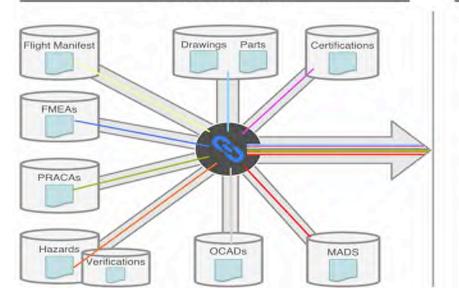


Integrated Information Systems for the International Space



















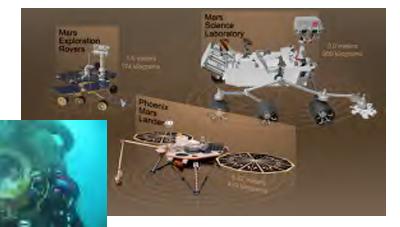




Ames Discovery - Innovations - Solutions

Planning and Scheduling Tools









*Ames

Mobile Applications for Operations and Systems Engineering!





*Ames

Vibration Impact on Human Performance!









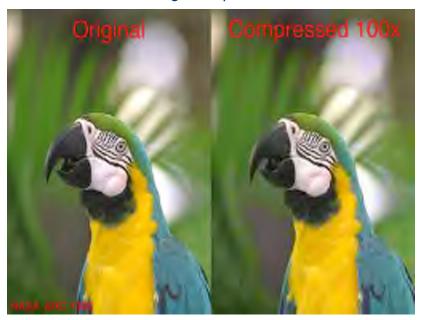




Vision Science and Visual Technologies!

Image Compression, Frame Rates and TBI Assessment

Image compression





Mathematics Sention > 5.2 for Mar Of 5 (66 bit) (date 25, 2005)

Aircraft/UAV Detection









Airspace Operations Laboratory!







Ames Solutions

Human Systems Integration for UAS and Single Pilot Operations (or "Reduced Crew Operations")!







Aviation Safety Reporting System (ASRS)!

- •" Processes voluntarily submitted incident reports from pilots, controllers, flight attendants and others.!
- •" Reports may describe unsafe and hazardous situations.!
- •" Receiving about 10,000 reports per month.!
- •" Established in 1976.!





FAA & NTSB Quick Responses



Research



Incident Reports



Alert Messages



Database Search Requests



CALLBACK Monthly Safety Newsletter



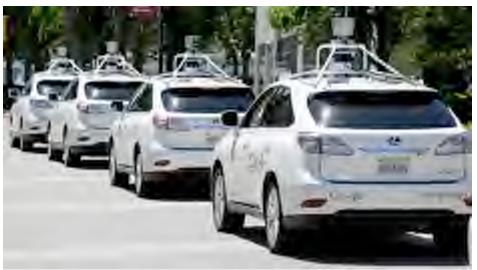
ASRS Directline Quarterly Safety Bulletin



*Ames

Google SDC Collaboration!







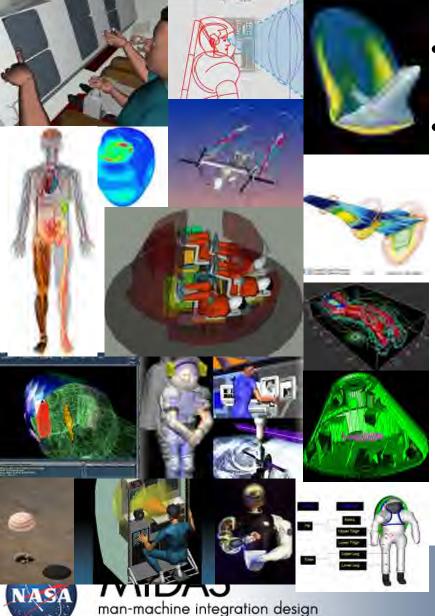


Just-in-Time Crew Training for Long Duration Space Missions!









and analysis system

- Modeling and simulation are critical to comprehensively study complex human-system designs
- Many different types of models exist at NASA
 - —" Human behavioral
 - –" Human performance
 - -" Anthropometric, biomechanic, volumetric
 - –" Information processing
 - -" Vision, auditory, memory, and other human processes
 - –" Task network
 - Physical structural (space launch vehicle, aircraft, crewstations, CAD/CAEs)
 - –" Airspace system
 - –" Weather
 - –" Airflow and other CFD
 - –" Physiological
 - Robotics and automation
 - –" Oxygen and blood flow
 - -" Scheduling

Human Systems integration division

NASA Ames Human Modeling in System Design

ACES: National Airspace

System

FACET: Air traffic management

• "Airspace

"Procedures

responsibilities

"Training

•"Roles &

"Scheduling

- "Aircraft Trajectories
- "Illumination
- "Gravitational forces

System and **Environment** Design

"Crewstation

- "Flight deck layout
- "Loads
- "Manual handling
- "Fluids and heat ransfer models

Physical Equipment Design

JACK: Anthropometric model

Biomechanic model MIDAS-FAST (& BORIS):

Robotics Trainer

Volumetric **CFD**

BRAHMS: Agent-based

models

MIDAS: Behavior models

Cognitive process models:

Decisions / response to

information

SPIFe/SCORE: Scheduling

and Planning models

Operations Design, Evaluation, and Integration

Technology Design, Evaluation, and Integration

- "Displays
- "Automation
- "Information Requirements

ADEPT: Human-**Automation Interaction**

HOP: Human Vision

Basic Process Models: Audition (e.g. threshold

models),

MIDAS: Memory &

cognitive processing







Technical Area

Laboratory

NASA Ames HSI Research Areas



http://humansystems.arc.nasa.gov/techareas/tech_areas.php

Research Area

Human Machine	HCI	Contribute to the development of better NASA software through careful application of iterative
Interaction (HCI)	The state of the s	user research, interaction design, and usability (Curiosity - MSLICE)
	Human Automation Interaction	ADEPT provides a tool for prototyping automation and associated interfaces, in an integrated tool that includes analyses to identify potential HAI vulnerabilities early in the design process
1	Scheduling and Planning	Scheduling and Planning Interface for Exploration (SPIFe) toolkit for space missions that includes human constraints on mission operations
Human Performance Research	Advanced Controls and Displays	Research on haptics, speech recognition, visual perception, visual perception in space, adaptation to virtual environments, and acoustics
	Human Vibration Laboratory	Assesses whole-body vibration impacts on visual, cognitive, and manual performance, understand the mechanisms contributing to vibration-induced performance deficits, and develop countermeasures to mitigate these deficits.
- Company to the contract of t	Flight Cognition Lab	Studies the cognitive, team and organizational processes that underlie the performance of pilots, air traffic controllers, and other skilled professionals
	Psychophysiological Lab	Studies altered gravitational effects on human autonomic and central nervous system function to maximize the health, productivity and safety of humans in space.
	Intelligent Systems	Enhance mission safety and crew efficiency in next-generation spacecraft by evaluating the operational impacts of environmental stressors and by developing and testing advanced operations concepts and crew-vehicle interfaces.
MIDAS	Man-machine Integration Design and Analysis System (MIDAS)	Develop human performance models of human-system interaction to predict operator performance along the measures of task performance and times, visual attention, workload, situation awareness
Integration and Training	Airspace Operations Laboratory (AOL)	Researches roles, responsibilities, and requirements for human operators and automation in future air traffic management (ATM) systems using human in the loop
	Human Centered Systems Laboratory (HCSL)	Focuses on mission safety and efficiency by developing innovative display technologies using both HITL and HPM methodologies
	Flight deck display research	works to increase the capabilities of the flightdeck crew by expanding their roles and



Human Performance Models







- Human Performance Models (HPMs) allow system designers the ability to model critical events that cannot be fully studied with empirical simulations
- Models can be used to provide estimates of human-system performance when the concepts, technologies, or automation are too new, difficult, or dangerous for the human operator
- Model validity is a paramount concern when predictions are generated to evaluate candidate NextGen operations







Motivation:



NextGen Technology Design, Evaluation, and Integration

•" NextGen Characteristics:

- -" More data available to the flight deck
 - •" e.g., weather, wake, traffic trajectory projections, etc.
- —" More precise and closely coordinated operations
 - •" e.g., self-separation, closely spaced parallel operations, RNAV/RNP
- —" More tasks are automated
 - •" Pilot increasingly placed in a monitoring role
- Potential for increased workload, decreased situation awareness, increased demand for shared attentional resources

•" Evaluating NextGen Concepts:

- —" Must consider pilots' capabilities when designing / evaluating NextGen procedures, operations, roles / responsibilities and the information requirements
- Failure to do so will leave the pilots, and thus the entire aviation system, vulnerable to error

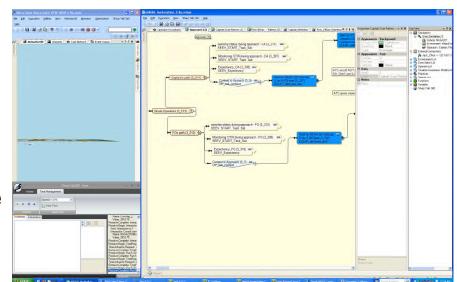




Man-machine Integration Design and Analysis System (MIDAS)

- ✓" Validated, first-principle models of human behavior including perception, visual attention, memory, & workload
- ✓ " 3D CAD models of the environment, the workstation, and the equipment
- ✓ " Controls a generic, anthropometrically-correct human mannequin (Jack™, 5th percentile female
 - 95th percentile male)
- ✓ " Monte carlo simulation capability with stochastic human performance



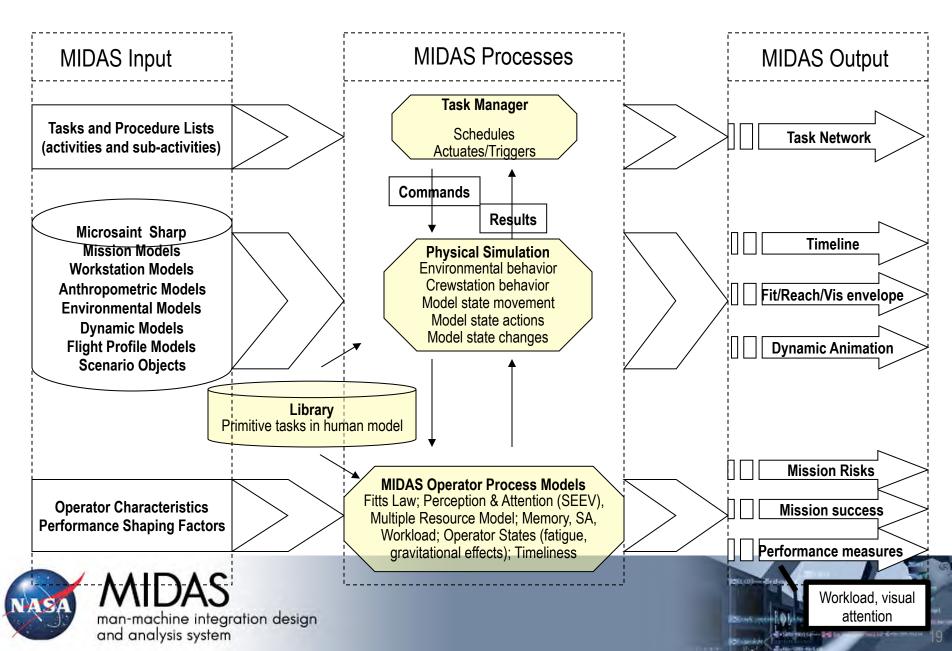


- ✓ " Distributed simulation (e.g. Microsaint Sharp)
- ✓ " Generates realistic task-management behaviors sensitive to task context, environment
- ✓" Produces task timelines, workload, and situation awareness profiles and visualization which permits testing of procedure alternatives



MIDAS v5 Structures





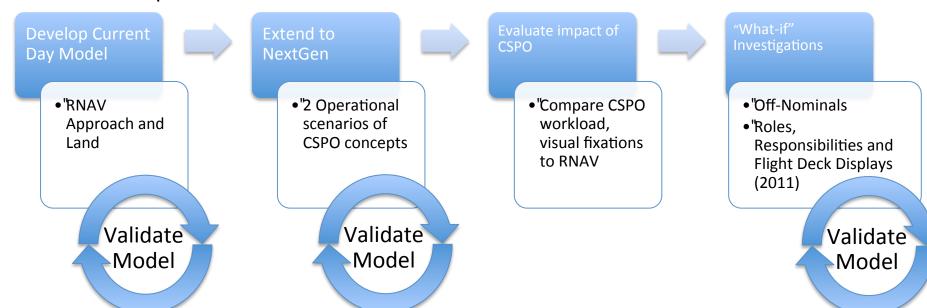




CSPO Project Overview

" Objective

—" Develop valid HPMs of approach and land operations, use these models to evaluate candidate NextGen concepts (Closely Space Parallel Operations, CSPO), develop guidelines regarding flight deck displays and pilot roles and responsibilities





Gore, B.F., Hooey, B.L., & Foyle, D.C. (BRIMS 2011, March 21-26).

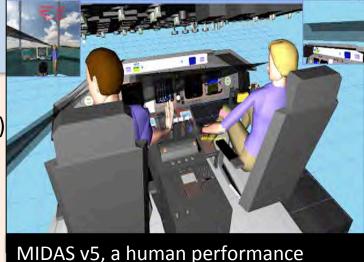
Evaluating NextGen Closely Spaced Parallel Operations Concepts with Validated Human Performance Models

Model Development and Validation

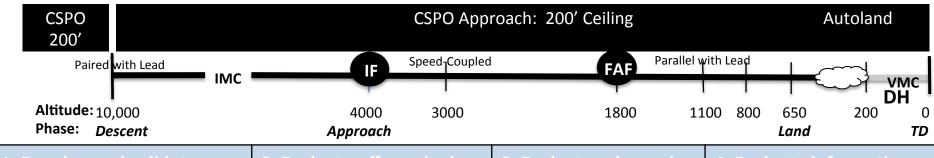
- -" <u>Develop</u> RNAV model based on task analyses (SME input)
- -" <u>Validate</u> model inputs, processes and outputs
- -" Extend RNAV model to two CSPO Concepts

event/alert detection response times

- -" <u>Evaluate</u>: Pilot-ATC separation responsibility, Wake Information Requirements,
 - Spacing Management Information Requirements Implications based on: Pilot workload, visual attention



MIDAS v5, a human performance model of the flight deck environment, pilots' workflow and cognitive processes.



-" RNAV scenario + 2 CSPO -"Pilot-pilot roles -"Flight deck information - Weather (high wind) (Allocation of task, required to support early operational scenarios - RNP Loss -"Validated model - FMS Failure monitoring workload) conflict detection and safe - inputs (Focus groups) - Aircraft of runway -"Pilot-ATC roles response - **processes** (Literature) (Conflict detection and -"Wake format and location -"Spacing Automation style - outputs (HITL data) resolution) and format





•" Insert MIDAS TOGA movie



CSPO Findings and Implications

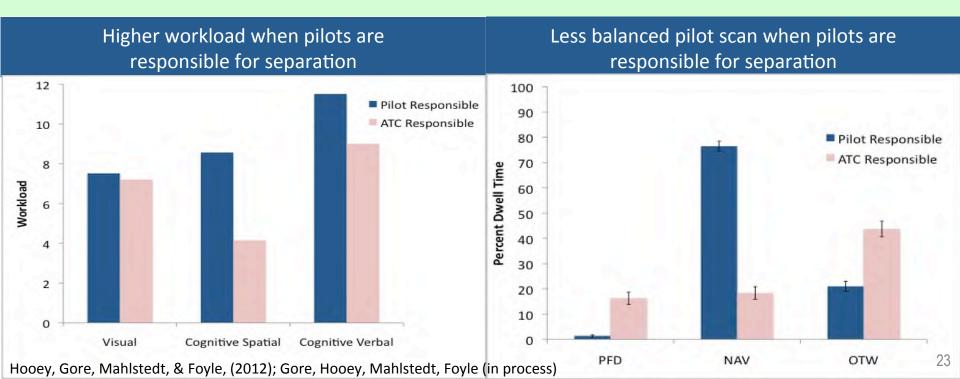
Human Systems integration division

Flight Deck Requirements for:

- 1." ATC-Pilot Roles and responsibilities: ATC vs Pilot responsibility for separation
- 2." Alert styles for wake and blunder threats: One-stage vs two-stage alerts
- 3." Wake display technology: Format (predicted vs real-time), Location (PFD, Nav Display, or Both)
- 4." Spacing management automation: Style (Current vs NextGen), Location (PFD, Nav Display, or Both)

Evaluating ATC-Pilot Roles and Responsibility: Separation Delegation

- -" Compared Current-day (ATC responsible for separation) with NextGen (Pilot responsible for separation)
- -" Model predicted slightly faster emergency escape maneuvers when Pilot's are responsible (.3 sec), BUT...



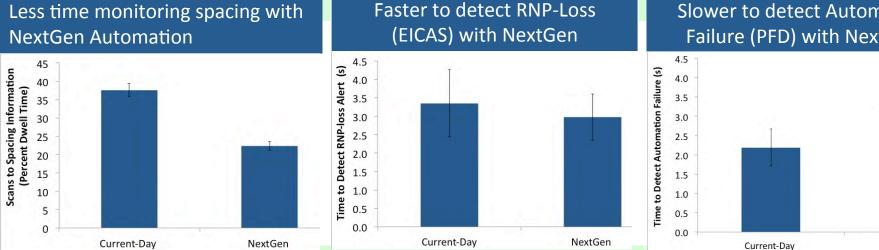
CSPO Findings and Implications

Flight Deck Requirements for:

- 1." ATC-Pilot Roles and responsibilities: ATC vs Pilot responsibility for separation
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- Wake display technology: Format (predicted vs real-time), Location (PFD, Nav Display, or Both)
- 4." Spacing management automation: Style (Current vs NextGen), Location (PFD, Nav Display, or Both)

Flight deck requirements for spacing management automation style

- Compared Current-day spacing management (MCP) with NextGen Automation (e.g. Airborne Spacing for Terminal Arrival Routes (ASTAR) algorithm; Murdoch, 2009)
- Extend Lozito et al. HITL results to assess pilot scan and response to off-nominal events



Slower to detect Automation Failure (PFD) with NextGen

NextGen

Current-day speed-management resulted in: increased pilot scans to spacing displays, faster detection of RNP-loss alert (on EICAS)

NextGen speed-management slowed time to detect automation failure on PFD (complacency)

Hooey, Gore, Mahlstedt, & Foyle (2012)

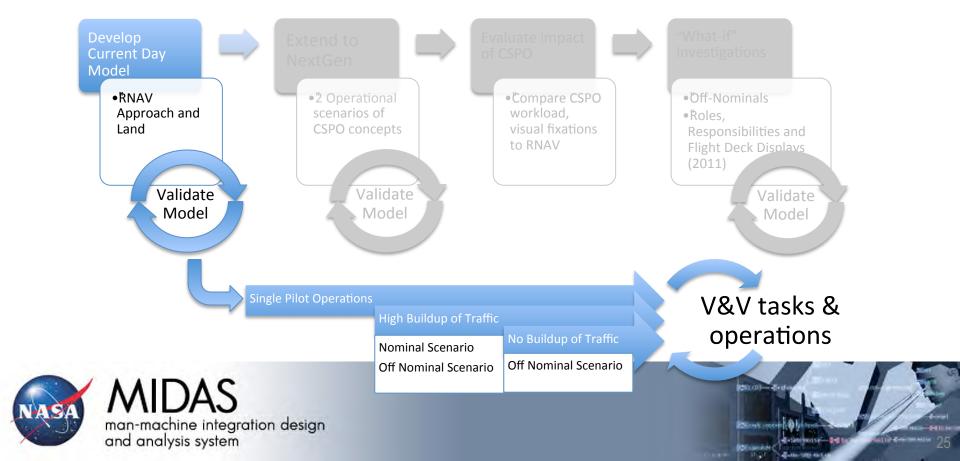




SPO Project Overview

" Objective

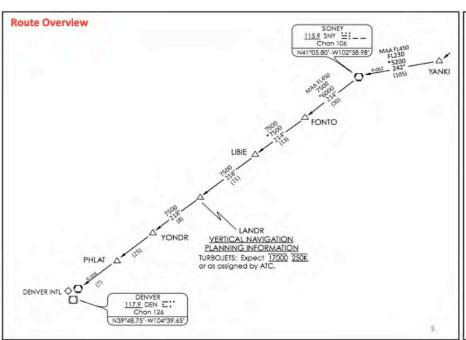
Complete a task analysis of the Pre-TOD to TOD tasks required in candidate
 Operational scenarios (Single Pilot Operations; SPOs)

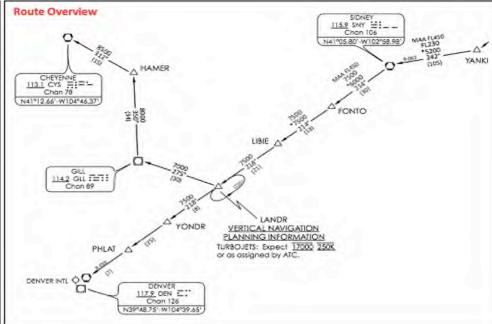




Denver Arrival Approach Plate

- •" Nominal Approach plate to DIA
- Off-Nominal (Divert Approach plate to Cheyenne)



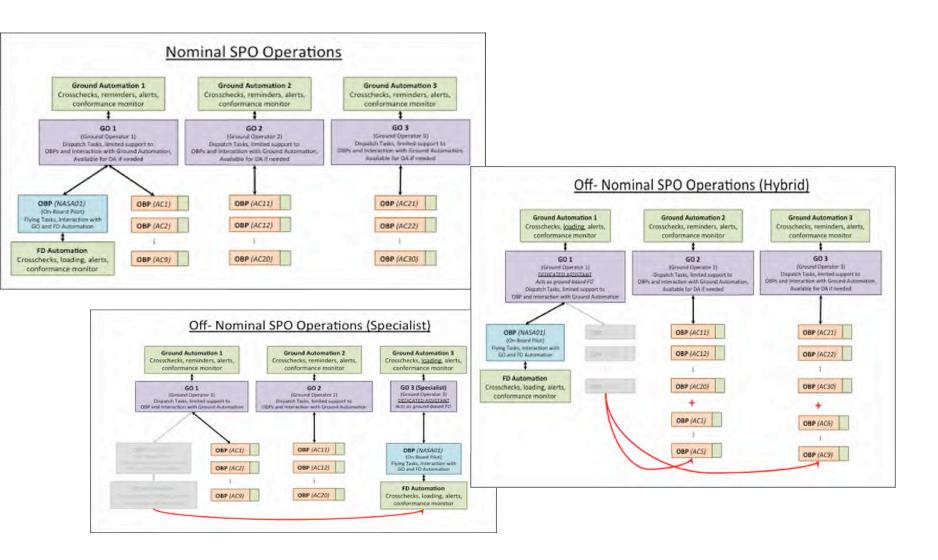




Human Systems integration division

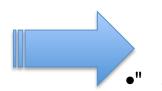








Human Systems integration division Single Pilot Operations Task Analysis



2013

4 entities

- Pilot on Board
- **Ground Operator**
- Automation
- ATC



- Nominal
- Off-Nominal
- SPO
 - Nominal
 - Off-Nominal

2014

9 entities

- Onboard Pilot
- FD Automation
- **Ground Operator 1**
- **Ground Automation 1**
- **Ground Operator 2**
- **Ground Automation 2**
- **Ground Operator 3**
- **Ground Automation 3**
- **ATC**

5 Scenarios

- **Current Day**
 - •" Nominal
 - Off-Nominal
- SPO High Build-up
 - Nominal
 - Off-Nominal
- SPO No Build-up
 - Nominal
 - Off-Nominal







Generating the 2014 Task Analysis

- •" Modified a verified set of flying tasks completed
- •" No FO/Limited FO
- "New dispatch tasks added (including handoffs)
- "Redistribution of tasks among 9 operators
- "All tasks must be assigned
- "Greater delegation to automation
 - —"When tasks were moved to automation, new crosschecking tasks arose for the human operators







2014 Task Analysis Output #1



SPOHLRI - Off-Nominal O/8 Divert to: CYS ILS HWY 27L 900* Clood Ceiling Category D SASAOL Pre TOD - TD

Altitude	Airpuri Distance	Pilot Piving On-Board Pilot NASA01 (CA)	NASA01 Automation	ATC (cues)	Pilot NOT Flying Ground Operator (Hybrid) I	Ground Automation 1	Pilot NOT Flying Ground Operator (Hybrid) 2	Ground Automation 2	Pilet NOT Flying Ground Operator (Rybrid) 3	Ground Automation 3
Prior to 19	nul Descent	Continuous tasks: Auditory and Instrument Monitor. Maintain a common schema.	Continuous tooks: Off-Nominal Alects. Phase of flight alects. Monline task adherence. Notification of non self-initiated system changes.	Continuous tasks: Maintain separation	Continuous tuske: Anditory & alert Monitor, Maintain a rommon schema. Maintain company schedule efficency. Provide dispatels information & limited support to OBP (NASAII), Available for DA if requested.	Continuous tasks: Off-Noninal Aierts, Monitor task, adherence. Transmit information packages. Transfer notification.	Continuous inclas Auditory & alect Monitor, Maintain a cutamon selector, Maintain a cutamon selector, Maintain company schedule effector, Pero del disputori information & Romed support to OBF (Other), Available for BA if equivaled.	Continuous resis: OS-Nominal shorts. Monitor task, adversice. Transfer inoffication.	Continuous national designation of the continuous accurant scheme. Materials a contrast schedule efficiery. From file disparch information de limited support to CIBP (Orion). Assimilate for DA if requested.	Continuous insis: Off-Sourion Aprils, Monitor task adherence, Transmit information packages, Transfer notification.
					Prepare briefing package for blandet/ (NASA01)		the Shot Flight Bristings			
		Pre Armval briefing/chocklist (Taus Chart, tax) route, gate, flaps, farget landing speed, descent speed, brake sellings, time of year, geographic posttoon)					Even Seroof process (NASABL ALIZAGS NEW ALIZ			
							START SIGHT	START SERFT		
							Scen Screen: Taile Status			
			Oct ATIS. Uplink to FMC, expected approach arrival info (Airport, runway, altimeter, arget speed, landing saps, DH, frequencies.) Notify.				Scan Screen: Tails Management			
		Crosscheck suto info					Speak of OHP ()			
		Energine auto indio					Review Fuel levels [1			
							Review Weather ()			
							Speak or OSP ()			
							Raylew Facil levels ()		Perform	GO:tasks
							Beview Weather ()			
							Speak w/ ORP ()			
							Review Fuel levels ()			
		Listen			Speak or OBP (NASARI) *Lioning to hands Tim OO2, have a rose English		Review Weather ()		-	
		Speak w/ GO *Roger, handoff initiated, goodingst*			Linker		Speak w/ OBP ()			
					Execute handoff (NASA01)		Review Fuel levels ()			
					Disconnect (NASA01)		Hevey Weater ()			
		Speak = OO					Speak w OEP (NASARI)			
		If good captain & threat is evident. Probad alternatives into FMS. Say "Probading alternate vito FMS."			Continues	GRO tarina	Raview Facil levels (NASA01)			
	TOD	Approach descent checkful					Beview Weather (NASA01)			
37,000	SIDNET									
		Essocute Altitude.	Send to ground suto				BECHN SPO III sociano events		-	
		Listen to ATC command		Say "NASA01 contact Denver Center, 133.95"			Scan Screen: Tails Status			
		Say "NASA01, Denver Center, 133,95"					Scati Screen: Tails Management			





2014 Task Analysis

- " Focused on defining task groups (for flexibility)
 - -" Dispatch
 - •" Scans for off-nominal situations
 - •" Addresses maintenance issues
 - " Reroutes
 - " Complies to Company standards
 - "Liaison between OBP and outside entities

—"OBP

- "Flying tasks (addresses clearances, executes clearances, communicates w/ ATC & GO)
- "Continuous Tasks- Crosschecks flight against CA's mental map

—" Automation

- •" Ground- Notifications: flight conformance, off-nominals, and reminders to act or check. Collect and organize flight information (handoff packages).
- •" FD- Notifications, Reminders, and Loads of clearances
- "Communicate between Ground & FD Automations





2014 Task Analysis Spreadsheet (Groups) 🐣



Ground Auto 2

Nominal Handoff: Giving 1, Getting 5			
COHI	Ground Auto 1	GOH2	Ground Auto 2
Prepare briefing package for Handelf (NASAMI)		Pro-Shift Plight Driefings	
		Review handoff buokinges (NASA01) AC2, AC3, AC4, AC51	
		START SHIFT	START SHIFT
- 1 (1		Soan Screen: Tails Status	
		Scan Screen Tails Munigement	
		Speak w/ OBP ()	
0.4 %		Review Fuel Jerels ()	
		Raylew Weather ()	
		Speak w/ OBP ()	
1 1		Review Fuel levels ()	
1		Review Weather ()	
		Speak w/ OBP ()	
		Review Fuel levels ()	
Speak w/ OBP (NASA01) "Going to handoff to GOH2, have a tree flight"		Review Weather ()	

Spool et Ook (I)	_
Review Feel levels ()	
Review Weather ()	
Speak w/ OBP ()	
Beview Fuel levels ()	
Seview Weather ()	-
Speak of OHP (NASABI)	
Review Fuel/levels (NASA01)	
Review Weather (NASA01)	-
	Review Fuel levels () Review Weather () Speak of OBP () Review Fuel levels () Review Weather () Speak of OBP (NASARE) Review Fuel levels (NASARE)

Handoff & Disconnect		
COHI	Ground Auto 1	
Scien Screen: Tails Status		
Scan Screen: Talls Mesagement		
Prepare briefing package for Handoff		
Review Fuel levels ()		
Review Weather ()		
Interset OBP ()		
"Going to handoff to GOH2, have a sice flight"		
Listen		
Review Handoff Package ()		
Execute hundoff ()		
Discounted ()		

AC2, AC3, AC4, AC5)	
Scan Soven: Tails Status	
Scua Screen Thills Management	
Beview Fuel levels (NASA01)	- [
Review Weather (NASA01)	
Speak w/ DBP (NASAH)	7
Beview Fuel levels ()	
Review Weather ()	
Speak w/ OBP ()	
Brview Fuel levels ()	7
Review Weather ()	
Speak w/ OBP ()	
Beview Fuel levels ()	
Review Weether ()	
Speak w/ OBP ()	-
Review Fuel levels ()	
Review Weather ()	
Speak w/ Offf ()	140
	Scan Screen: Tails Messgeness Beview Funkievels (NASA01) Review Weather (NASA01) Speak w/ OBP (NASA01) Review Fuel levels () Beview Fuel levels () Speak w/ OBP () Review Fuel levels () Speak w/ OBP () Review Fuel levels () Speak w/ OBP () Review Weather () Speak w/ OBP () Review Weather () Review Weather () Speak w/ OBP () Review Weather ()





2014 Task Analysis Spreadsheet (Groups) ** Human Systems integration division



Nominal Fligh	t Review		
Som Screen: Tails Sums	Ground Auto 2	New Ou	thoma
Sain Scient Talle Management		GOH2	Ground Aque 2
Review Altitude & Heading ()		Scan Screen Tailly States	
Beview had levels ()	Sout Series (Time Management)		Notify: New Orthorod ()
Review Weather ()		Preser (Inflowed list release Clock weather ()	
		Pressare (Patherend for reluses Cliente (Light plan ()	

Single Her	doff		
COH2	Ground Auta 2	Fool Temps	satures
Propert Priceling process for Handrill		COH2	Ground Auto 2
Speak w/ DRP () "Going to hondo"() to		Sour Smian Tvily States	
GOH2, have a nice flight		Son Screen: Tails Vinagement	
Listen		Theas fiel Temperation ()	
Execute hardoff ()		Send tou rough mor fact traps ()	
Discountest ()			

		Security into	rmation
Below 15,500		GOH2	Ground Auto 2
GOH2	Ground Auto 2	Scan Screen: Thilly States	
Brylov Attinut & Blooding ()	\$45 0th (1000)	Scan Screen: Tails Management.	
Renew Fuel ands ()		Receive and Understand persons:	
Soon Wester()		Stock w/ORP()	
and analysis system	i uesigii	Dinama Security information	



2014 Task Analysis Spreadsheet (Groups) 🐣



		Weather Re	routing
Delay		GOH2	Ground Auto 2
GOH2	Ground Autn 2	Scart Scoren: Timi Status	
Receive and Lindonstand mentions		Scian Science Tails Management	
(ATC) "Dylam at ORD due to weather"		Receiv and Underland pressings	
Scien Scroon: Tail+ Status		ATC) *Conventive strenged	
Scar Screen: Talla Mesagement		Between Fuel Invols ()	
Review Altitude & Heading ()		Herion Weather ()	
Review Fuel Lewis ()		Interact OliP ()	
Review Weather ()		Discuss: Waither remarking	
Speak or IXIP() Disease: Airport inhound delays		Mainten	III CE
Speak of Continue pare team. Disuse: Delays ()		GOH2	Ground Auto 2
Speak w/Reservation poordinator		Listen	
Dissess Delays ()		Speak wt OOP () Discuss: Maintenance Problem "Do you have any safety obscerne?"	
Gate Coun	ectations	Listen	
GOH2	Ground Auto 2	Speak wt OOP ()	
Scan Screen: Tails Surins		Discuss Maintenance Solution "Rapper, contacting maintenance"	
Salai Savies/ Talla Managemen		Speak w/ Municounce ()	
Speak w/ DRP () Disease Unite Correction Problem		Patch through maintenance (collaboration possible)	
Speak of DRP () Discussi Tute Cormection Solution		Speak of OOP () "Maintenance will you meet you in	
Corres: Reservation coordinator Disease Cate Competions ()		the gate* Review Eucl levels ()	
ana analysis system		Review Weather ()	



2014 Task Analysis Spreadsheet (Groups - DA)

Human Systems integration division

Dedicated A	Assistance
GOH2	Ground Auto 2
Notified of wx at DEN, possible hold and divert (NASA01)	Notify: Wx @ DEN
Review Fuel (evels (NASA01)	
Review Weather (NASA01)	
Listen DA request (NASA#1)	
Review Altitude & Heading (NASA01)	
Confirm DA request (NASA01)	
Handoff other AC - No briefing	
Speak w/ OBP (NASA#1): "How can 1 help?"	
Listen	
"Roger, locating."	
Locate approach plates (CYS/EGE/COS/G/T/PUB)	
Send plates to NASA01	Send plates to NASA01 auto
Review weather (CYS/EGE/COS/G/T/PUB)	
Send weather to NASA01	Send weather to NASA01 auto
Discuss current state	
Agree on preliminary best alternate (CYS)	
Littern	
Centinn daties	
Load primary alternate Airport (CYS)	Notify NASA01 auto
Discuss probable hold locations & pattern, Discuss fuel state and calculate endurance for a hold. (Find burn to DEN, Desired DEN landing fue). Current burn rate, Time-fael remaining, Crosscheck.)	
Pre-load probable hold into CDU	Notify NASA01 auto
Discuss Alternate 1 (CYS) (distance/time/fue/CAT/ATIS) (x2)	
2999011	
Discuss Alternate 2 (EGE) (distance/inte/fuel/CAT/ATIS) (x2) Action	
TVO:	
Discuss Alternate 1 (COS) (distance time/fuel/CAT/ATIS) (A2)	
Andrea	

	12
Listen to ATC command, Decide on Cheyerne (CYS) as the alternate. Discuss firel state and calculate endurance for a held with CYS as new destination. (Find burn to CYS.	
Desired CYS landing fact. Current burn rate. Time-fact remaining. Crosscheck.)	
Say "NASA01 maintaining 17,000", will hold at LANDR" Say "Denver Center, NASA01 at LANDR, time 15, 17,000"	
	Notify GO
Crosscheck OBP	
Listen to ATC	1.0
Listen to ATC command. Decide to divert to CYS (the Decide piece requires that alternates are removed from consideration by a process of climination - weather, distance to land, and fuel - OTHERS?). Execute Alternate 1 Plan.	
Action	
"Denver Center, NASA#1 request IFR clearance to Cheyenne via direct"	
Listen to ATC	
	Load CYS as new destination in CDU. Get ATIS. Build a route, Load expected Approach/Arrival Information: Airport, Runway, Altimeter, Speed changes, landing flaps, DH, frequencies, Load LNAV/VNAV, Norsily GO.
Crosscheck AUTO info	
Monitor PF Pre-Arrival Briefing. Crosscheck	
Listen to AIC	
Say "Roger, NASA01, 281 to GILL, maintaining 17,000."	

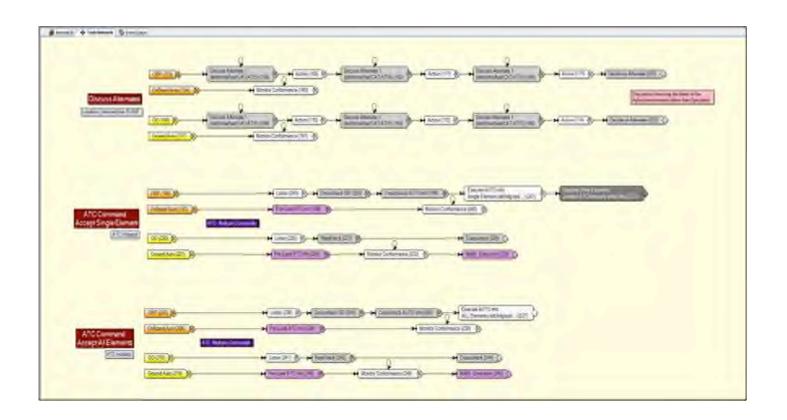
Listen to ATC

Say "Roger, NASA01, 350, direct to	
HAMER, direct CYS, descend and maintain 10,000, expect runway 27	
approach; eltimeter 28.15"	
approach, annixar 20015	
	Nonity GO
Crosschack OBP	
	Notify GO
Crosscheck OBP	
	Set I ground Altimeter Notify GO & NASA01
Crosscheck 3 Altimeters	
Listen to ATC	
Say "Roger, NASA01, 124.55"	
Say *Cheyenne Approach, NASA01,	
one zero thousand with Alpha."	
Listen to ATC	
Say "Roger, 9000 for NASA01"	
Notified	Notify GO
Crosscheck OBP	
Listen	
Speak w/OBP: "Roger, releasing dedicated assistance"	
Lasten	
internet NASA01: "No problem, goodnight."	
Notified	Nonly GO





Implementing Task Analysis Output# https://division Task Representation and Coding



	Altitude	Airport Distance	Pilot Fiving On- Board Pilot NASA01 (CA)	NASA01 Automation	ATC (cues)	Pilot Ground Op	NOT Flying Ground Automation I perator (Hybrid) 1	Filst NOT Flying Ground Operator (Hybrid) 2	Ground Automation 2	Pilot NOT Flying Ground Operator (Hybrid) 3	Ground Automation 3
NASA-Ames R			Speak w/ GO: Discuss Cade connection problem					Speak w OBP (NASABI) Discuss: Gate Connection Problem			
7			Speak of GO: Discuss Cade connection solution					Speak w. OHP (NASA01) Discuss. Gain Commention Solution			
tc			Lsen				Dispatch	Speak w. Reservation con Americ Discuss Gate Connectors (NASA01)			
ba			Speak in OOs Discuss Whoolchare				Dispatch tasks	Speak w/ OBP (NASA01) Discuss: Wheel chairs			
<u>.</u>							cosks	Find Clair Information ()			
			Lists					Speak w/ Customer care learn Discuss: Wheelchairs (NASA01)			
A			Pre-Arrival briefing, Class Chart, taxi route, gate, flaps, target landing apood, descent speed, brake settings					Monius PF Pre-Arrival Briefing Crosscheek			
1 //			Listen to ATC command	Pre-load ATC info	Say "NASA01 Fly heading 281 GILL, maintain one seven thousand"			Listen to ATC			
\			Crowcheck (IC)		Say "NASA01, Fly			Say "Roger, NASA01, 281 to GILL, maintaining 17,000."			
ask Analysis Spreadsheet (w/ DA Dispatch)			Linken to ATC	Pre-Jonal ATC in the	handing 350, Cleared direct HAMER, direct CYS, Gentered and maintain 10,000, expect tunway 27 approach to CYS, Cheyenne altimeter 28.15*			Lesten to ATC			
Sh			Crowcheck GO					Say "Roger, NASA01, 350, direct to HAMER, direct CYS, devocad and traintain 10,000, expect runway 27 approach; altimeter 28.15			
ğ			C4 crowcheck. If Schema no correct, get ATIS & amend Approach briefing.					happengaves, messenceses acc. s.c.			
69			Execute route	Send to ground auto				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Notify GO		
2								Crosschack OBP			
S			Exit hold	Send to ground auto				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Notify GO		
S	-			Set 2 cockpit Altimeters		§		Crosschack OBP	Set I ground Altimeter	-	
S				Notify NASA01 & GO				1	Nouly DO & NASA01	_	
	3,879*	49 nm	-Crosscheck 3 Altimeters Approaching GILL (IAF) at 10000'					Crosscheck 3 Altimeters			
па	3,879	99 mm	Laten to ATC	Pre-load ATC info	Say "NASA01 conduct Cheyenne Approach on 124.55"			Listen to ATC			
A			Crowcheck GO		124.23			Say "Roger, NASA01, 124.55"			
\ <u>\\</u>			Ececute frequency 124-55 for Chayenna Approach								
, 9,			Speak in GO "Forward lavrious in Issuing"					Laten			
			Loan					Speak w. OHP (NASA/1) Discuss Maintenance Problem "Do you have any safety concerns?"			
2014			Speak w CO. No, have mentionance ready on the ground at DEN."				Dispatch	Laten			
2			Lism				Dispatch tasks	Speak w. OBP (NASA61) Discuss Maintenance Schulen Roger, contacting maintenance			
NA								Speak w Mannenance (NASA0T) Patch through maintenance (collaboration possible)			
X			Lines				Caminus GO taiks	Speak w. OBP (NASA01) 'Maintenance will you moo you althoughte' the gate'		Caciin	saes DiCreasion 37

	Altitude	Alrport Distance	On-Board Pilot NASA01 (CA)	NASA01 Automation	ATC (cies)	Pilot NOT Flying Ground Operator (Hybrid) 1	Ground Automation 1	Film No. 12 ing Ground Operator (Hybrid) 2	Ground Automation 2	Pilos NOT Flying Ground Operator (Hybrid) 3	Ground Automation 3
NASA-Ames k			Speak w/ GO: Dooses Cude connective problem					Lyten & Crosscheck Books (Array)		Speak of OSP (NASA01) Discuss Code Connection Problem	
4			Speak or GO: Discour Cate consection solution					Listen & Crosschock Route/Armeal		Speak or One (NASA01) Discour Diver Connection Solution	
)tc			Lisen					Listen & Crosscheck Bassie Arraval		Speak of Reservation conditation Discuss Cate Connections (NASANI)	
bg			Spoil in OOx Discuss Whodelases					Listen & Crosscheck Route/Arrival		Social = OSP (NASA01) Decision Wheel chairs	
)is								Crowcheck House/Arrival		First Owe Information ()	
			Lases					Laten & Crowcheck Route/Arryal		Speak = Castomer care (cam Decess Wheelchary (NASA91)	
30			Pre-Amyor briefing Class Chart, too route, gain, flaps, surger landing speed, descent speed, brake settings					Monitor W. Pre Arrival driefing Cromelinek		Parture and Undorstand moongs (ATC) "Delays at ORD due to resulted."	
>			Listen to ATC command		Say "NASA01 Fly bracing 181 GILL number one seven through?"			Linters to ATC		Scan Screen, Tails Status	
٤			Crowcheck (90)		E-Pilew P-	Constitues	GO Theles	Say "Roger, NASA01, 281 to CILL. meaning 17,000."		Scan Screen: Tails Management	
ask Analysis Spreadsheet (w/ GO Dispatch)			Lister to ATC	Pre-load ATC info	Say "NASAOI, Fly braiding 350, Cleared divid HAMER, direct USS, descond and maintain 10,000, expect ranway 27 approach in CVS, Cleyenne altimator 28.15"			Listen to ATC		Review Altitude & Beading ()	
Sh			Cromulyeck GO					Say "Roger, NASA01, 350, direct to HAMER, direct CYS, descend and meintam 10,000, expect runway 27 approach; altimeter 28.15"		Review Fuel Lavels ()	
aq			EA conscheds If Schwar aut corned, get ATIS & amend Approach briefing.							Rayley Weather ()	-4
e)			Execute owne	Send to ground unto				1	Ne5 00	Speak w/ OBP () Disease: Aurord inhound delays	
d								Crosscheck OBP		Speak w. Customer care team Discuss: Delays ()	
S			Feit held	Send jo ground unio					Needy GID.	Speak w/ Revervation coordinator Discuss, Delays ()	
<u>.</u>				Set 2 cyckpii Alümesers				Crosscheck OBP	Sei 1 ground Altimeter	Scan Scroen: Tails Status	
/S				Noticy NASA01 & GO					Noticy GO & NASA01	Sosn Screen. Tails Management	
	3,879*	49 nm	Crosschook 3 Altimeters Approaching GHA (IAF) as 10000°					Crosscheck 3 Alumo ers		Raysew Altrinde & Heading ()	
Πa	,,,,,		Listen in ATC	Pre-Joud ATC in to	Say "NASA01 contact Cheyenne Approach on 124.55"			Listen to ATC		Heview Fuel levels ()	
<			Crewcheck GO					Say "Roger, NASA01, 124.35"		Havsew Weather ()	
×		-11	Execute frequency 124.55 for Cheyenne Approach							Scan Screen: Tails Status	
9.			Speak w GO "Forest landary o learing"					Listen & Plan		Libáco	
			Lises			Constitutes	GO hate:	Lesten & Plan		Speak of CHP/(AASAB1) Discount Mendomore Problem "Do you have my salidy amounts?"	
17			Speak wi (20) "No, have maintenance really on the ground at DEN."					Listen & Plan		Dine	
2014			tists					Listen & Plan		Specia to COP (A LAAR) Dracom Mantoninos Solotion "Bage ambiente removement"	
NA			Ligar					Say "C'hayesne Apptosch, N.K.S.A00, one zero thousand with Alpha."		Spain of Management (NASAM) Point from the section of the control	
			Lises					Listen & Plan		Speak of OSP (NASMI) "Management will jost poet jost al, "He gase"	38





2014 Task Analysis

•" Included:

- –" Nominal "shift change" handoff as one of the first task groups
- —" Nominal ramp-up
- -" Off-Nominal handoff
- —" Off-Nominal ramp-up
- -" "End-of-DA" handoff
- —" "End-of-DA ramp-up
- -" Dispatch tasks

•" Discovered:

- —" Greater reliance on automation
- —" Ground Automation (new)
- —" "Dispatch" Automation (new)
- —" New Relationships
 - •" GO > GO, GO > FD, FO > GO, OBP > GO, CA > FO
- —" What happens during a DA handoff?
 - •" Who is responsible for the dispatch tasks?
 - Should a Ground FO in DA have assigned duties, or are they determined by the CA > FO relationship?









Task Analysis Output #2

Current Day Nominal

					Cui	y Nomin			Current Day Off-North						lat			
				C/	1	FO		60	ALL	-2			'A	F)	9	(10	ALL
Lo	Low Total Low Workload Percent Low		18	3	18		2	38	Tota	al Low	2	7	2	4		2	53	
Work			21.1	21.18% 21,43%		0	33.33%	21.71%	Percent Low		22.88% 2		21.2	1.24% 33		3.33%	22.36%	
Med	Medium Total Medium		ledium	53	,	61		3	117	Total M	Total Medium		70		78		3	151
Work	Workload Percent Med		Medium	62.3	5%	72,629	6	50.00%	.66.86%	Percent Medium		59.	59.32% 69		.03% 50.		6900	63.71%
Hi	and control of the second		al High	High 14		5		1	20	Tota	Total High				11		1	33
Workload		Pensent High		16.47%		3.95%		16.67%	11.43%	THE RESERVE AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS N				9,7	9,73%		67%	13.92%
HP III	methods on	Total Tasks		85		84		6	175	Total Tasks		S 118		113		6		237
Total Task		Percent Entity		48.5	48.57%		Va .	3.43%	100,005	Percent	Entity	entity 49.1		47.6	8%	2.5	53%	100.00%
	3	SPO II	ybrid	I N	ominal					SPO	SPO Hybrid		LOff-Nor					
			OBR	PE	OTUA	- Cit		COAUTO	ALL			OBP	ED A	_	60		OTUACI	ALL
ow Worklean	d	Total Low		29 42		×		15	94	Total Lo	Total Low		40 58		24			159
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Tasks	Percer	Percent Mediam 54		0.00%		44.44%		0.00%	31.75%	Percent Media	m 49.65%		0.00% 5		57,32%	57,32% 0,00%		36,79%
ligh Workhoa	4	Total High			0			0	12	Total Hi			0		U		0	(2
Tasics	Pe	Percent High		S (0.00%		24	0.00%	7.50%	Percent Hi		21.99% -		1%	13,41%		0.00%	13.21%
Total Tasks		Percent Finity 5		35 42 13% 26.25%		11.25%		15	160	Total Tax	_	141	18.24%		25.79%		37	318
TOTAL PASSES	Pen							9.38%	100.00%	Percent Ent	4	1.34%					11.64%	100,00th
	SPO Specialist Non				nmal		the same					ialist Off-Nominal		minal				
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m Workhad		0.0000	29	42	3		Ш	15	14	Total Low	45	_	54	9		02	46	166
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gh Warkhard		T- Committee			3	7		0.0012	33.75%	Felal High	32	- //	0	3		8	0,00,12	43
Tinks	Penni			0.00% 11.11		25		0.00%	7.50%	Payan Kiji			0,00%		9,68% 0,00		0,00%	12.54%
		25 THE RESERVE		17			****		T// T/	Total Tasks	146		54	31	1 6	16	40	343

100,00%

9.38%



Total Tasks

man-machine integration design and analysis system

26,25%

31/25%

13/419

15.74%

0.049



Human Systems integration division

Summary

- 1." HPMs such as MIDAS can be used to evaluate:
 - —"Pilot/ATC tasks, roles and responsibilities, and function allocation
 - —" Technology development and integration
 - -" Error or safety vulnerabilities
 - —"Procedures and training needs
- 2." HPMs and the modeling approach can be applied to other:
 - -"Phases of flight, (e.g. aviation arrivals, enroute, departures, taxi and their transitions; space ascent, descent; ISS operations)
 - -"Flight deck technologies (e.g., SVS/EVS; CDTI; EFBs; MFDs;)
 - —" Information requirements manipulations
 - -"Concept of Operations evaluations (e.g. Single Pilot Operations)
 - "Space operations (e.g. ISS and CEV/SLS procedure design and evaluation)
 - —" Human-automation interaction domains









NASA's use of human behavior models for concept development and evaluation

Brian F. Gore
Human Systems Integration Division
NASA Ames Research Center
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